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Bat diversity from an area of coastal Atlantic Forest in southeastern Brazil

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Abstract

We characterize the bat fauna of forested sites in the municipality of Domingos Martins, Espírito Santo state, southeastern Brazil, and update the list of bat species of the state. We conducted a rapid inventory using ground-level mist nets (27,000 m²·h effort) and occasional roost searching, which resulted in a list of 23 species belonging to Phyllostomidae (18 species), Vespertilionidae (3), and Molossidae (2). We report the first record of *Molossops neglectus* Williams & Genoways, 1980 and *Myotis lavali* Moratelli, Peracchi, Dias & Oliveira, 2011 from Espírito Santo, bringing the total number of confirmed species in the state to 86. The molossid *Nyctinomops laticaudatus* (É. Geoffroy, 1805) was exclusively recorded in its diurnal roost in rocky outcrops. Our study fills knowledge gaps in the distribution of bat species in southeastern Brazil, and more specifically in the highly diverse coastal Atlantic Forest of Espírito Santo. These data reinforce the importance of continuously inventorying and documenting bats in the Neotropics.

Keywords

Chiroptera, Espírito Santo state, new records, species distribution, species list

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Introduction

The Atlantic Forest biome, which corresponds to 15% of the Brazilian territory, occupies the eastern South American coast from the state of Rio Grande do Norte to the state of Rio Grande do Sul (SOS Mata Atlântica; Pereira 2009). This biome is a hotspot of biodiversity, containing up to 8% of the global biodiversity and largely contributing to the recognition of Brazil as a megadiverse country and signatory of the Biodiversity Convention (Mittermeier et al. 2004; Silva and Casteleti 2005; Varjabedian 2010; Oliveira and Irving 2011). Espírito Santo state, located in the southeastern region of Brazil, is nested within the southern part of the Atlantic Forest realm and has approximately 8% of its territory covered by well-conserved Atlantic Forest (Moreira et al. 2008; Vela-Ulian et al. 2021). The landscapes of Espírito Santo encompass elevational gradients from sea level to higher mountain chains and present unique vegetation combinations and highly diverse ecosystems (Silva and Casteleti 2005) that shelter a diverse, yet poorly known, bat fauna (Mendes et al. 2010).

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Eight families and 84 species of bats have been recorded in Espírito Santo (Hintze et al. 2020; Vela-Ulian et al. 2021). This represents approximately 46% of the bat species listed for Brazil (181 species; Garbino et al. 2020). Although Espírito Santo has one of the richest bat faunas among Brazilian states, its bat fauna is one of the less studied in the country (Mendes et al. 2010; Vela-Ulian et al. 2021). Remarkable contributions on the bat fauna of Espírito Santo from last century include the pioneering work of Augusto Ruschi in the 1950s decade (Mendes et al. 2009) and more recently studies conducted from the 2010s on (e.g., Peracchi et al. 2011; Duda et al. 2012; Nogueira et al. 2012; Hoppe et al. 2014a, 2014b; Hintze et al. 2020; Vela-Ulian et al. 2021). However, large sampling lacunes remain and most inventories have been concentrated in conservation units. The forested, mountainous central-eastern area of the state remains one of the least-sampled regions (Moreira et al. 2008).

Here, we present the results of a rapid, two-season bat inventory conducted in a forested area in the municipality of Domingos Martins in central-eastern Espírito Santo. We report new records of bats for the state and discuss the importance of conserving at least part of the large areas not yet included in conservation units, such as those studied here.

Study Area

This study was conducted in the municipality of Domingos Martins (20°21′50″S, 040°39′35″W), a mountainous region located in central-eastern Espírito Santo, southeastern Brazil (Fig. 1) at approximately 500 m above sea level. The region is covered with wet, largely well-preserved tropical semideciduous seasonal forests and has a high-altitude Tropical climate with rainy summers.

Methods

Bats were sampled using ground-level mist nets placed in five sites in continuous forest (points 1, 3 and 4) and fragments (2 and 5) (Table 1; Fig. 1). We conducted 10 sampling nights in 2011, from February 18–25 (wet season) and from April 1–7 (dry season). We erected 15 ground-level mist-nets at each site (12 × 2.5 m, or 30 m^2), which remained open over six hours (5:30 pm–11:30 pm) and checked for bats at maximum intervals of 30 minutes. We also conducted a one-day diurnal roost searching in the rocky outcrops (site 6; Table 1) (Fig. 2). Individuals were marked with numbered metal rings attached to a plastic neck collar and released in the same place that they were captured. Collected specimens were deposited in the mammals' collection of the Department of Zoology of the Universidade Federal of Minas Gerais. The identification of the bats was based on the keys available in Gardner (2008), Miranda et al. (2011), and Reis et al. (2017), and on additional taxonomic literature (i.e., Woodman and Timm 2006; Velazco et al. 2010; Moratelli et al. 2011; Wilson and Mittermeier 2019). Taxonomy follows Wilson and Mittermeier (2019) and Garbino et al. (2020).

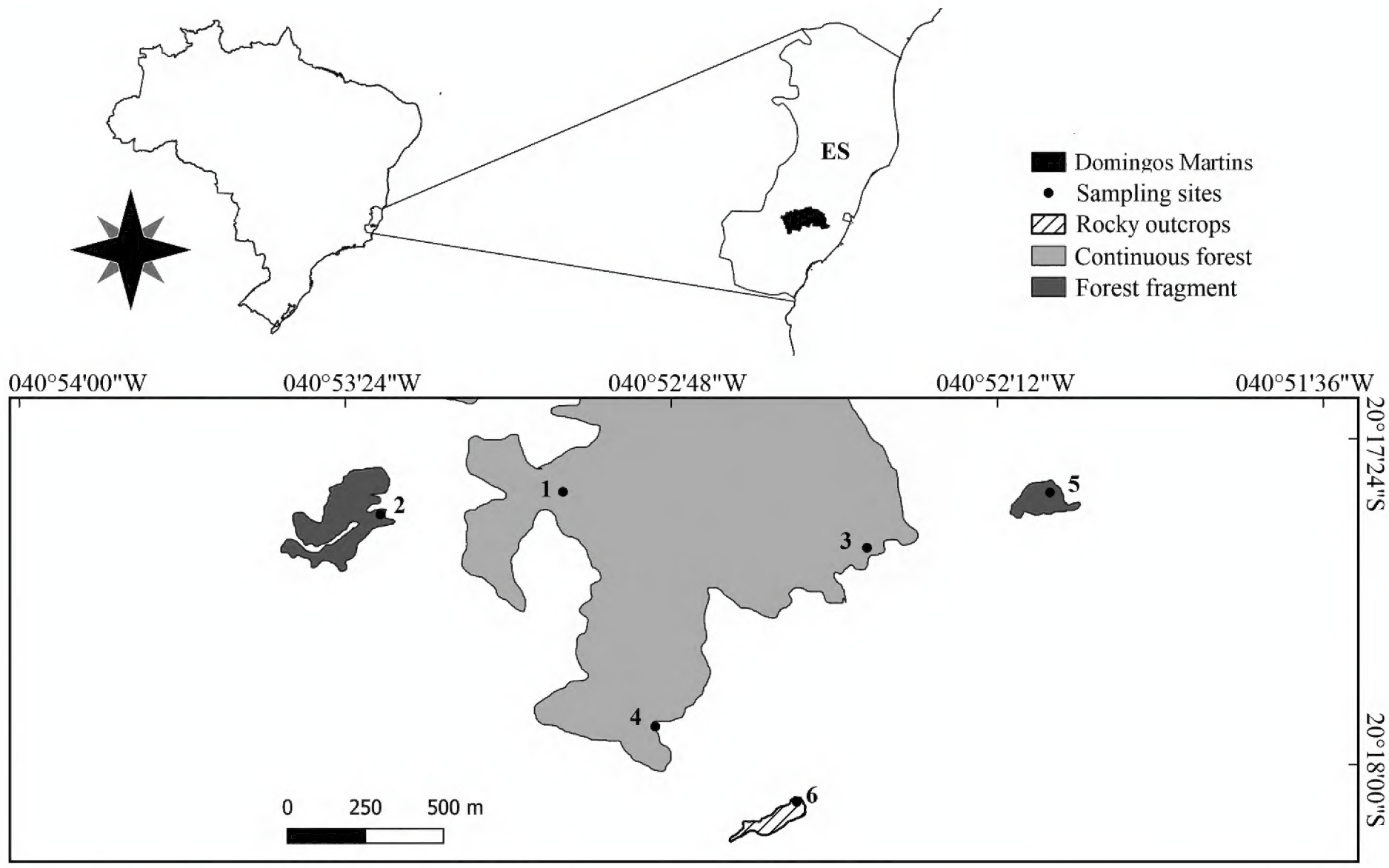

Figure 1. Map of the sampled area within Domingos Martins, Espírito Santo, southeastern Brazil. Light gray area is a continuous forest, dark gray areas are forest fragments, and the hatched area is the rocky outcrops area. Sampling points are the same as those listed in the Table 1.

Table 1. Description of sampling sites at Domingos Martins region, state of Espírito Santo, southeastern Brazil, with geographic coordinates and sampling effort.

Habitat	Sites	Altitude (m)	Coordinates	Sampling effort (m^2·h)
Continuous forest	1	831	20°17′29.87″S, 040°52′59.96″W	5,400
	3	676	20°17′36.05″S, 040°52′26.39″W	5,400
	4	660	20°17′55.80″S, 040°52′49.76″W	5,400
Fragmented forests	2	719	20º17′32.39″S, 040°53′20.15″W	5,400
	5	643	20°17′29.93″S, 040°52′6.19″W	5,400
Rocky outcrops	6	744	20°18′3.29″S, 040°52′33.48″W	–

Figure 2. Rocky outcrops inspected during diurnal searching in Domingos Martins, Espírito Santo state, southeastern Brazil. The arrow indicates a crevice where the bats were roosting.

We used the sample coverage estimator developed by Chao and Jost (2012) and implemented in the online software iNext (Chao et al. 2016), available from https://chao.shinyapps.io/iNEXTOnline/ to obtain rarefaction and extrapolation curves based on 40 knots with a 95% confidence interval set to 100 replications of bootstrap resampling. We discriminated species and individuals in separate foraging guilds as proposed by Kalko et al. (1996).

Results

Our sampling efforts totaled 27,000 m^2·h and captured 369 bats belonging to 23 species of Phyllostomidae, Vespertilionidae, and Molossidae (Table 2). Phyllostomidae was the more frequently sampled family, corresponding to approximately 78.5% of the species and 96.3% of captures.

The most abundant species were *Artibeus lituratus* and *Artibeus planirostris* representing, respectively, 20.32% (75 individuals) and 19.51% (72 individuals). *Anoura geoffroyi*, *Chrotopterus auritus*, *Lionycteris spurrelli*, *Lonchorhina aurita*, *Platyrrhinus recifinus*, and *Sturnira tildae* were relatively rare in our sampling (1.68%), represented by a single capture (Table 2).

Most species (17 of 23) were recorded in the continuous semi-decidual forest, whereas 16 were captured in the forest fragments. The following 11 species were found in both habitats: *Anoura caudifer*, *A. lituratus*, *A. planirostris*, *Carollia brevicauda*, *C. perspicillata*, *Desmodus rotundus*, *Eptesicus brasiliensis*, *Myotis albescens*, *Platyrrhinus lineatus*, *Pygoderma bilabiatum*, and *Sturnira lilium*. *Nyctinomops laticaudatus* was the only species recorded by our one-day diurnal active search roosting in the rocky outcrops.

Table 2. Bats recorded in Domingos Martins, Espírito Santo, Brazil. Abreviations: FC = continuous forest, FF = forest fragment, AR = rocky outcrop, N = nectarivore, F = frugivore, C = carnivore, H = hematophague, AI = aerial insectivore, GI = gleaning insectivore.
* Newly recorded from Espírito Santo state.

Family, subfamily	Species	Relative abundance			Relative frequency (%)	Guild
		FC	FF	AR		
PHYLLOSTOMIDAE						
Desmodontinae	*Desmodus rotundus* (É. Geoffroy, 1810)	24	9		8.94	H
Lonchorhininae	*Lonchorhina aurita* Tomes,1863	1			0.28	GI
Phyllostominae	*Chrotopterus auritus* (Peters, 1856)		1		0.28	C
Glossophaginae	*Anoura caudifer* (É. Geoffroy, 1818)	2	4		1.62	N
	Anoura geoffroyi Gray, 1838		1		0.28	N
Lonchophyllinae	*Lionycteris spurrelli* Thomas, 1913	1			0.28	N
Carolliinae	*Carollia brevicauda* (Schinz, 1821)	30	9		10.56	F
	Carollia perspicillata (Linnaeus, 1758)	28	20		13	F
Rhinophyllinae	*Rhinophylla pumilio* Peters, 1865	3			0.81	F
Stenodermatinae	*Artibeus lituratus* Olfers, 1818	36	39		20.32	F
	Artibeus planirostris (Spix, 1823)	25	47		19.51	F
	Artibeus cinereus (Gervais, 1855)	2			0.54	F
	Platyrrhinus lineatus (É. Geoffroy, 1810)	10	13		6.23	F
	Platyrrhinus recifinus (Thomas, 1901)		1		0.28	F
	Pygoderma bilabiatum (Wagner, 1843)	1	1		0.54	F
	Sturnira lilium (É. Geoffroy, 1810)	14	25		10.56	F
	Sturnira tildae de la Torre, 1959	1			0.28	F
	Vampyressa pusilla (Wagner, 1843)		8		2.17	F
VESPERTILIONIDAE						
Vespertilioninae	*Eptesicus brasiliensis* (Desmarest, 1819)	2	1		0.81	AI
	Myotinae *Myotis albescens* (É. Geoffroy, 1806)	2	2		1.08	AI
	Myotis lavali Moratelli, Peracchi, Dias & Oliveira, 2011*	2			0.54	AI
MOLOSSIDAE						
Molossinae	*Molossops neglectus* Williams & Genoways, 1980*		2		0,54	AI
	Nyctinomops laticaudatus (É. Geoffroy, 1805)			2	0.54	AI
Total		**184**	**183**	**2**		

The rarefaction and extrapolation curves indicate that we have a subsample of the local richness (Fig. 3). Frugivores predominated (over 55%) in terms of composition in the forested areas (Fig. 4A), with insectivores corresponding to 23% of the total number of species. We captured three species of aerial insectivorous bats and one gleaning insectivorous bat in the continuous forest (23.5%) and three aerial insectivores (19%) in the forest fragments. In respect to nectar-feeding bats, we captured two species in both the continuous forest (11.8%) and in the forest fragments (12.5%). We also captured one hematophagous and one carnivorous species in both areas (Fig. 4A). Fruit bats were more abundant, corresponding to over 80% in each habitat (Fig. 4B), and hematophagous bats represented the second most abundant guild, with 24 individuals (13%) in the continuous forest and

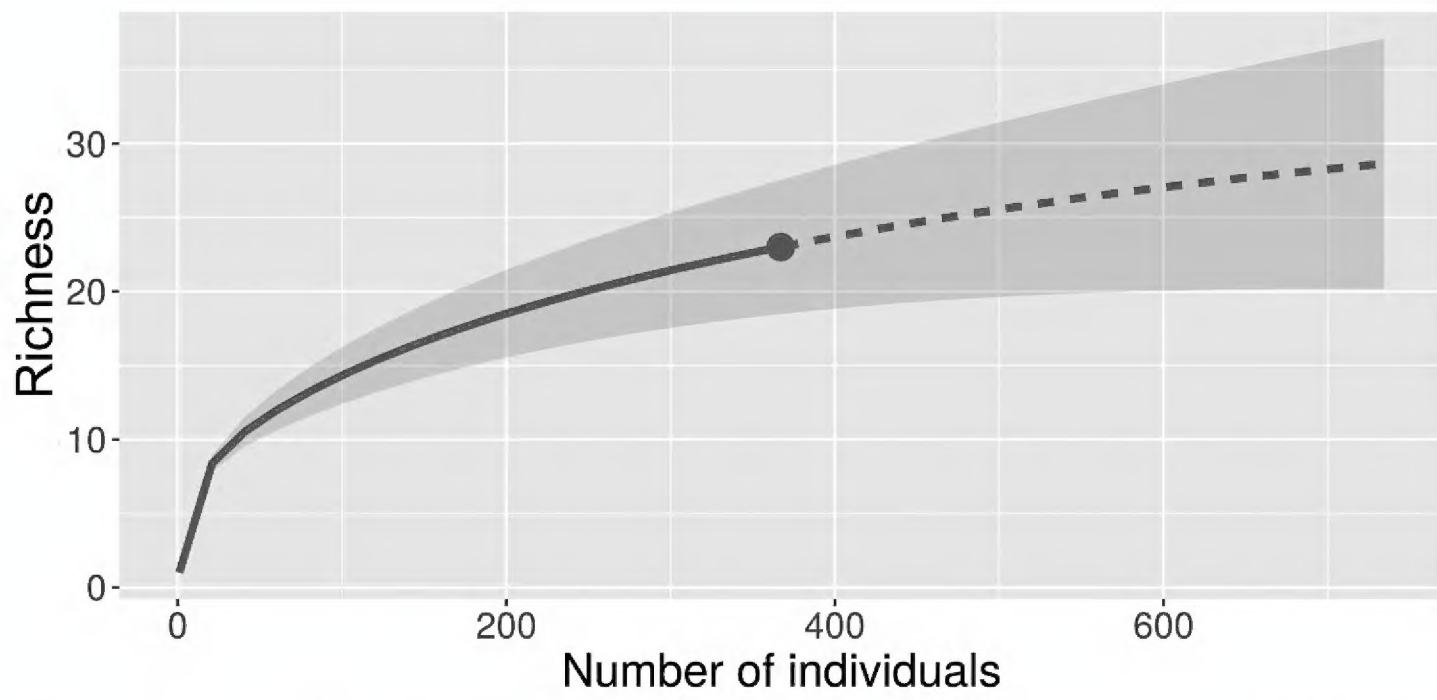

Figure 3. Rarefaction and extrapolation curves performed by the online software iNEXT (Chao et al. 2016), based on the number of captured individuals in the Atlantic Forest of Domingos Martins, Espírito Santo state.

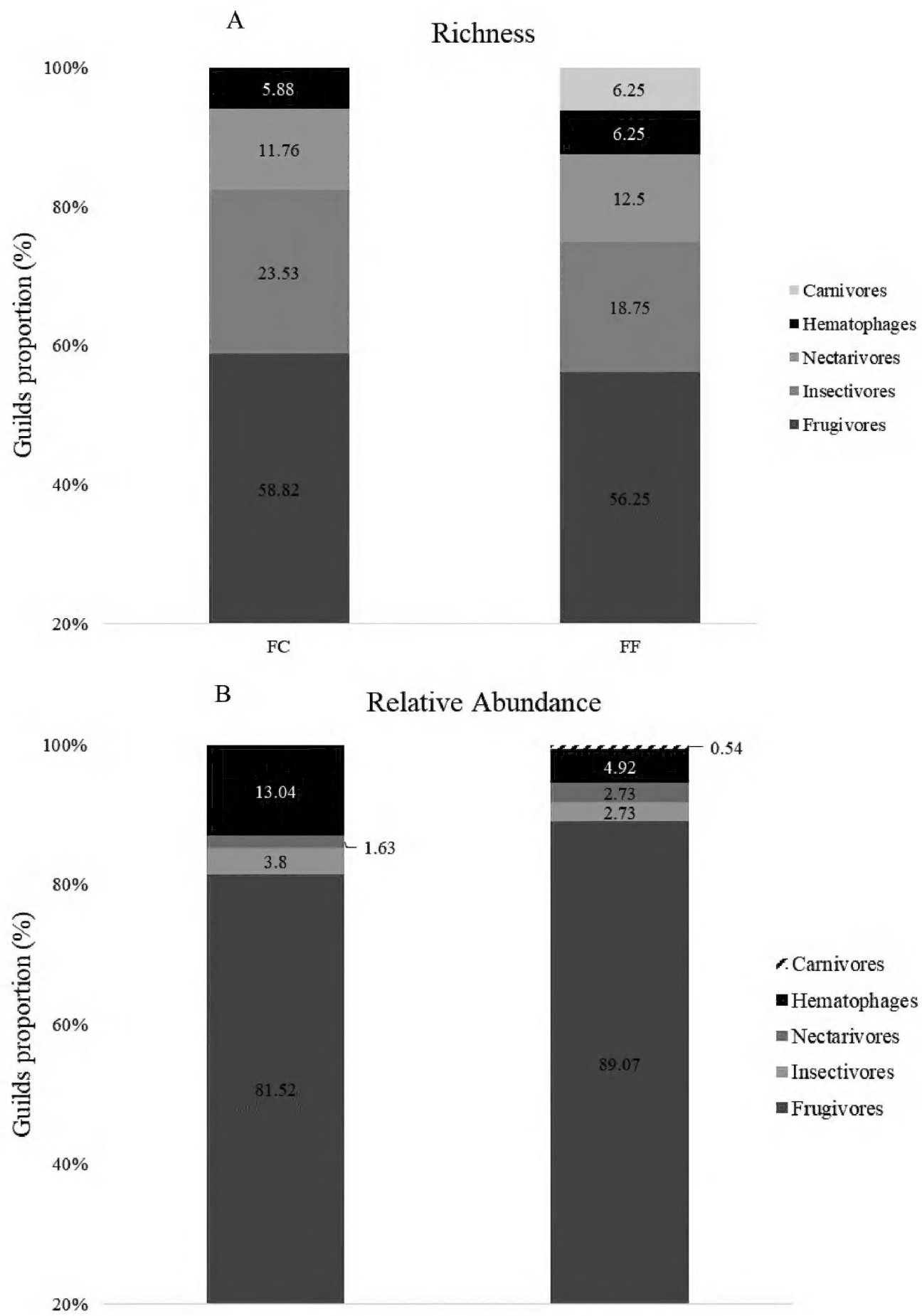

Figure 4. Representativeness of bat trophic guilds in the continuous forest sites (FC) and forest fragments (FF) in the Atlantic Forest areas of Domingos Martins, Espírito Santo, based on richness (**A**) and abundance (**B**).

nine individuals (5%) in the forest fragment. Nectarivorous, insectivorous, and carnivorous bats encompassed, each group, less than 5% of captures in the two areas (Fig. 4B).

Order Chiroptera
Family Phyllostomidae

***Desmodus rotundus* (É. Geoffroy, 1810)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7639); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 17 adult ♀, 16 adult ♂.

Identification. Short face, with reduced noseleaf forming simple fold over nostrils; thumb greatly elongated, longer than hind foot, and with two basal pads.

***Lonchorhina aurita* Tomes, 1863**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′36.05″S, 040°52′26.39″W, 676 m alt. (UFMG 7659); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♂.

Identification. Very long ears, tragus and noseleaf; Length of noseleaf more than three times its width, with the proximal portion hairy; forearm 51.8 mm; greatest length of skull 20.3 mm.

***Chrotopterus auritus* (Peters, 1856)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.93″S, 040°52′6.19″W, 643 m alt. (UFMG 7663); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♂.

Identification. Forearm 91 mm; tail very small, rudimentary; two pairs of lower incisors.

Anoura caudifer **(É. Geoffroy, 1818)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7648); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♀, 5 adult ♂.

Identification. Elongated muzzle with lower jaw protruding slightly beyond upper lip; tail membrane reduced, semicircular, reduced calcar, and has fringe of scarce hairs; forearm 36.4 mm.

Anoura geoffroyi **Gray, 1838**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.93″S, 040°52′6.19″W, 643 m alt. (UFMG 7661); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♀.

Identification. Elongated muzzle with lower jaw protruding slightly beyond upper lip; tail membrane reduced and hairy; legs and toes hairy, sides of feet with short hairs; forearm 42.3 mm.

Lionycteris spurrelli **Thomas, 1913**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7647); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♂. (Fig. 5A).

Identification. Rostrum conspicuously shorter than braincase; dorsal pelage dark brown with a cream-white basal narrow stripe (Fig 5A), in contrast with some relatives like species of *Lonchophylla* and *Hsunycteris* that present dorsal pelage clearly bicolor, with about two-thirds of paler base (Fig 5B); medial portions of the uropatagium conspicuously covered by hairs; forearms naked. External measurements: forearm 32.7 mm, ear 12.7 mm, tragus 4.1 mm, tail 6.0 mm, weight 8.0 g.

Carollia brevicauda **(Schinz, 1821)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7651); 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7668); 20°17′29.93″S, 040°52′6.19″W, 643 m alt. (UFMG 7677); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 17 adult ♀, 23 adult ♂.

Identification. Forearm length comprised in the interval of 35.5 mm to 42.5 mm; long dorsal fur, with evident banding patterns in individual hairs, consisting in marked dark bases occupying half of their total length.

Carollia perspicillata **(Linnaeus, 1758)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7642, UFMG 7669); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 25 adult ♀, 22 adult ♂.

Identification. Forearm comprised in the interval of 37.5 mm to 44.5 mm; short dorsal fur and banding patterns of individual hair less evident, and dark proximal band occupying less than ¼ of the total length of each hair.

Rhinophylla pumilio **Peters, 1865**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′36.05″S, 040°52′26.39″W, 676 m alt. (UFMG 7657); 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7673); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 3 adult ♀.

Identification. Dorsal and ventral hairs bicolored; uropatagium narrow and naked; tail absent; first upper incisor notched and much larger than the second upper incisor; forearm 32.9–34.1 mm.

Artibeus lituratus **(Olfers, 1818)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7652); 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7672); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 38 adult ♀, 37 adult ♂.

Identification. Dorsal fur brownish; forearm comprised in the interval of 68–75.7 mm; faint facial stripes present and well defined; horseshoe of the noseleaf not attached to upper lip; uropatagium and legs covered by hairs; molars 2/3.

Artibeus planirostris **(Spix, 1823)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7646); 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7675); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 32 adult ♀, 40 adult ♂.

Identification. Forearm comprised in the interval of 61.5–70.3 mm; facial strips present but not evident; horseshoe of noseleaf free; uropatagium narrow and unfurred; molars 3/3.

Artibeus cinereus **(Gervais, 1856)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′55.80″S, 040°52′49.76″W, 660 m alt. (UFMG 7678); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 2 adult ♀.

Identification. Forearm comprised in the interval of 40 and 42 mm; brownish dorsal pelage and hairs with four bands; uropatagium dark gray and broad, with dorsal surface slightly haired; molars 2/2.

Platyrrhinus lineatus **(É. Geoffroy, 1810)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7653); 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7671); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 12 adult ♀, 11 adult ♂.

Identification. Facial strips white and evident; dorsal and ventral pelage tricolored; forearm comprised in the interval of 43–50.1 mm; first upper incisors in contact.

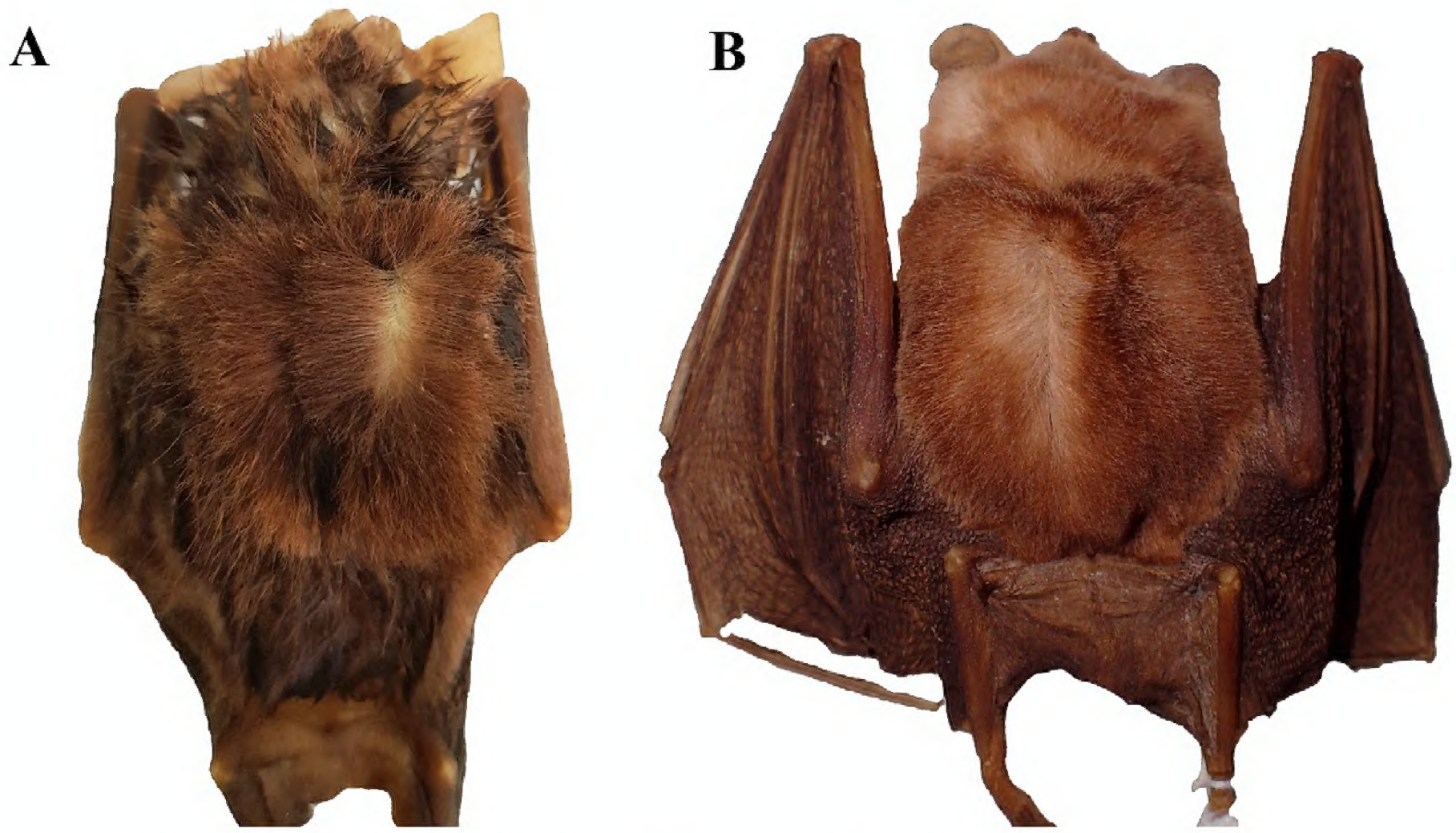

Figure 5. Dorsal pelage coloration of (**A**) *Lionycteris spurrelli* (UFMG7647) and (**B**) *Lonchophylla mordax* (MZUFV 2486). Note the cream-white basal narrow stripe in *L. spurrelli* contrasting with the evident bicolored pelage in *L. mordax*. Photo of *L. mordax* courtesy of Guilherme S. T. Garbino.

***Platyrrhinus recifinus* (Thomas, 1901)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.93″S, 040°52′6.19″W, 643 m alt. (UFMG 7664); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♂.

Identification. Facial stripes white and evident; dorsal hair with four bands and ventral hairs with three; forearm 39.6 mm; labial and lingual cingulids on fourth lower premolar present but not stylar cuspulids.

***Pygoderma bilabiatum* (Wagner, 1843)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7654); 20°17′55.80″S, 040°52′49.76″W, 660 m alt. (UFMG 7679); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♀, 1 adult ♂.

Identification. Olive eyes and internal surface of pinna yellowish; pair of white fur patches on shoulders and another pair on the sides of the neck; skin fold on lower lip virtually naked, hairless, on upper and lower lips; maxillary bones largely inflated and giving a cuboid form to the rostrum; molars 2/2.

***Sturnira lilium* (É. Geoffroy, 1810)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7645); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 23 adult ♀, 16 adult ♂. (Fig. 6A)

Identification. First upper incisors unicuspidate, procumbent, and at least twice the height of the I^2; forearm comprised in the interval of 40.2–44.6 mm.

***Sturnira tildae* de la Torre, 1959**

Material examined. BRAZIL – Espírito Santo • municipality of Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, alt. 831 m alt. (UFMG 7644); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♀. (Fig. 6B)

Identification. First upper incisors broad and weakly bilobed; forearm 44.4 mm.

***Vampyressa pusilla* (Wagner, 1843)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.93″S, 040°52′6.19″W, 643 m alt. (UFMG 7665); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 6 adult ♀, 2 adult ♂.

Identification. Dorsal pelage pale brown, with tricolored hairs; ventral hairs unicolored, light brown; pair of moderately conspicuous white facial strips on head; ventral pelage unicolored; forearm 31.4–33.9 mm; there is a gap between the upper incisors, and the I^1 is twice the size of I^2; molars 2/2.

Family Vespertilionidae

***Eptesicus brasiliensis* (Desmarest, 1819)**

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 76740, UFMG 7643); 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7674); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with

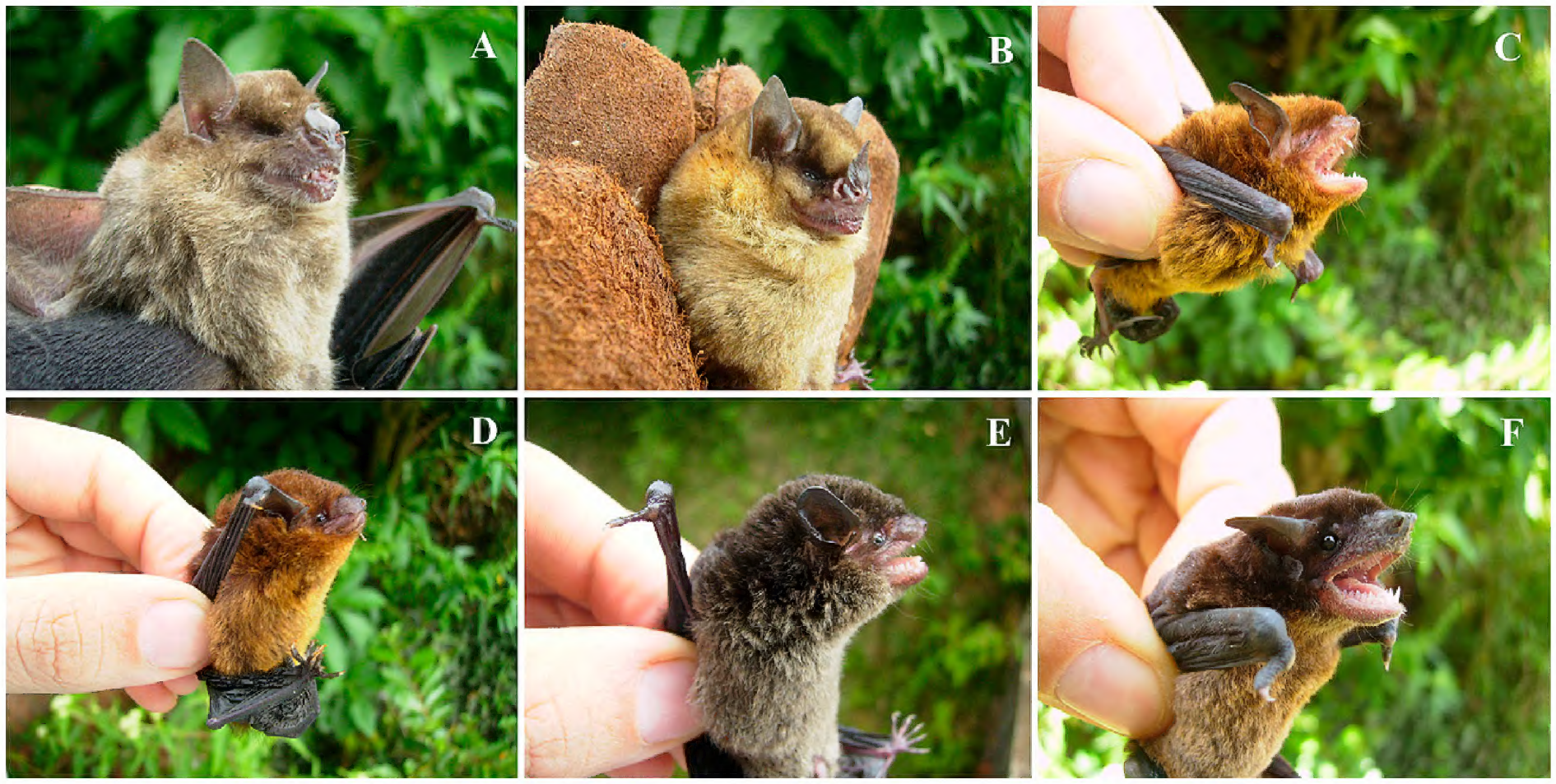

Figure 6. Bats of Domingos Martins, Espírito Santo state, southeastern Brazil. **A.** *Sturnira lilium*. **B.** *Sturnira tildae*. **C.** *Myotis lavali*. **D, E.** *Eptesicus brasiliensis*. **F.** *Molossops neglectus*.

mist nets; 3 ♂. (Fig. 6D, E)

Identification. Dorsal hairs relatively long (8.1–9.3 mm), almost homogeneous, with basal ¾ dark brown or dark reddish brown and slightly tan tip; ventral hairs dark brown or reddish brown with yellowish to whitish tips; forearm 42.7–44.5 mm; greatest length of skull 16.4–17.1 mm; sagittal and lambdoidal crests well developed; maxillary toothrow 6.4–6.6 mm.

Myotis albescens (É. Geoffroy, 1806)

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′29.87″S, 040°52′59.96″W, 831 m alt. (UFMG 7641); 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7655); 20°17′55.80″S, 040°52′49.76″W, 660 m alt. (UFMG 7660); 20°17′29.93″S, 040°52′6.19″W, 643 m alt. (UFMG 7662); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 4 ♂.

Identification. Dorsal hairs bicolored with dark brown bases and antique brown tips; plagiopatagium attached to feet by a broad band of membrane; presence of fringe of hairs along the edge of plagiopatagium; ear length 11.5–13. 3 mm; sagittal crest almost imperceptible, very low; small skull (GLS comprised in the interval of 13.1–13.8 mm).

Myotis lavali Moratelli, Peracchi, Dias & Oliveira, 2011

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′36.05″S, 040°52′26.39″W, 676 m alt. (UFMG 7656, UFMG 7658); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 2 ♂. (Figs. 6C, 7A–C)

Identification. Dorsal pelage bicolor with medium brown bases and lighter tips, ventral hairs strongly bicolor; ears short (12.4–13.8 mm), tragus pointed curving outward above and convex below, with small triangular lobule at outer base; absence of fringe of hairs along the edge of the uropatagium; small skull (GLS: 13.3–13.4 mm) with long rostrum and rounded braincase; supraoccipital rounded and sagittal and lambdoidal crests low; P^3 is aligned in tooth row.

Family Molossidae

Molossops neglectus Williams & Genoways, 1980

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°17′32.39″S, 040°53′20.15″W, 719 m alt. (UFMG 7649, UFMG 7650); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; collected with mist nets; 1 adult ♀, 1 adult ♂. (Figs. 6F, 7D–F)

Identification. Dorsal pelage short and dark brown; antero-dorsal pinnae are separated by a space of more than 4.5 mm, antitragus turned back; upper border of nostrils surrounded by small and pointed warts; forearm large (female= 36.4 mm; male = 37.7 mm) and without small wart-like granulations on dorsal side; incisors 1/1; less developed premetacrista on third upper molar, reaching a half-length of the postmetacrista.

Nyctinomops laticaudatus (É. Geoffroy, 1805)

Material examined. BRAZIL – Espírito Santo • Domingos Martins; 20°18′3.29″S, 040°52′33.48″W, 744 m alt. (UFMG 7666, UFMG 7667); 2011; V.C. Tavares, C.F.S. Palmuti, J.D. Gomes leg.; recorded by roost searching in rocky outcrops; 1 adult ♀, 1 adult ♂.

Identification. Proximal edge of ears on forehead; face with flexible and thin hairs; forearm 44.7–46.2 mm; greatest length of skull 17.3 mm; incisors 1/2; narrow palatal emargination.

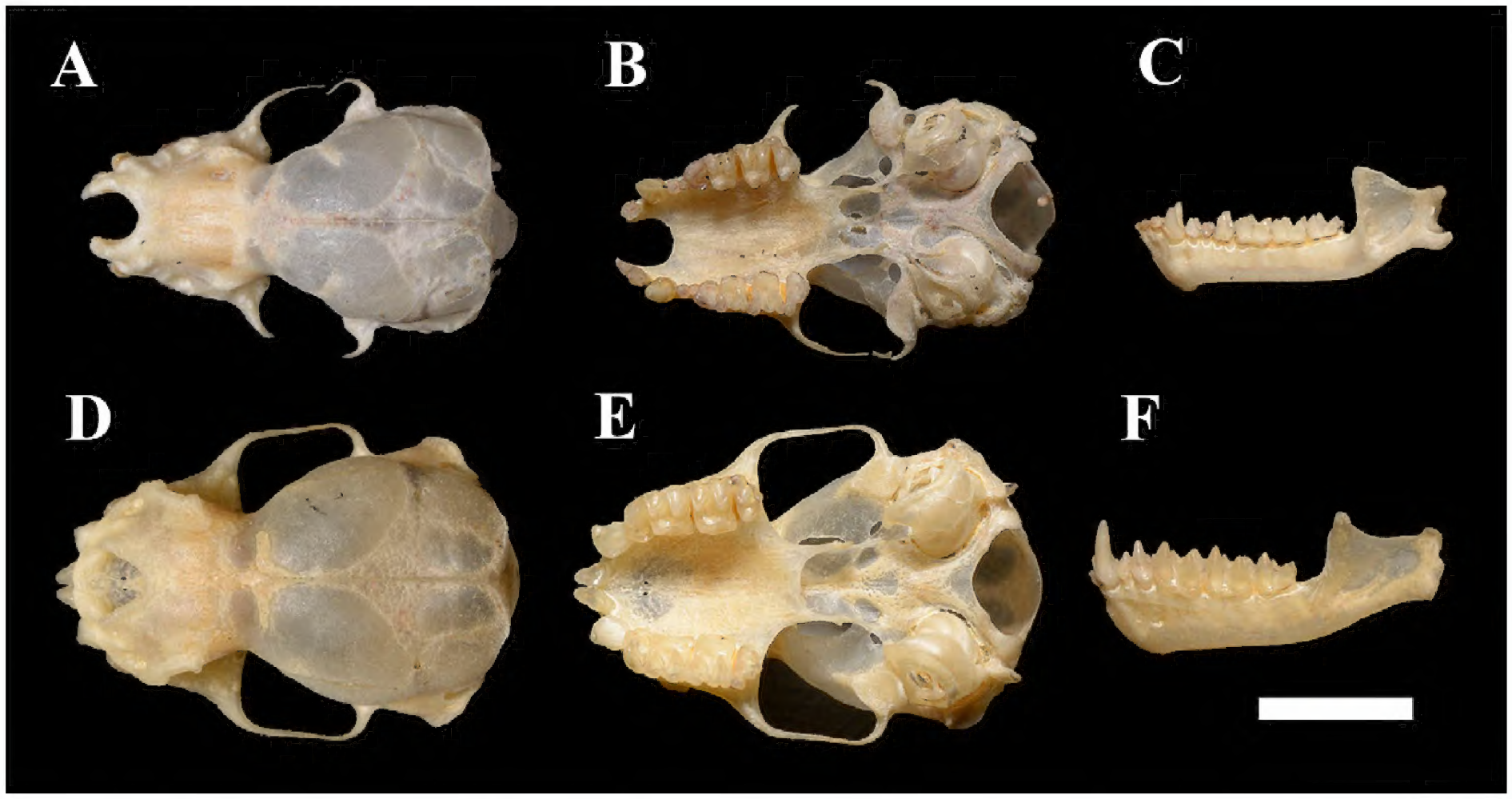

Figure 7. Dorsal and ventral views of the skull and lateral view of the mandible of individuals corresponding to the new records of bat species for Domingos Martins, Espírito Santo. **A–C.** *Myotis lavali* PCH86 ♂. **D–F.** *Molossops neglectus* PCH21 ♀. Scale bar = 5 mm.

Discussion

With 23 species, Domingos Martins harbors 27% of the bat fauna recorded in Espírito Santo (86 species; present study; Hintze et al. 2020; Vela-Ulian et al. 2021) and 18.8% of the bat fauna known from the Atlantic Forest (122 species; Figueiredo et al. 2021). However, the bat richness of Domingos Martins is still underestimated, as indicated by the rarefaction and extrapolation curves (Flaquer et al. 2007; Esbérard and Bergallo 2008; MacSwiney et al. 2008; Skalak et al. 2012). With the inclusion of *Molossops neglectus* and *Myotis lavali*, Espírito Santo has 86 species of bats, ranking it as the second richest state in bat species of southeastern Brazil. The state that ranks first is Minas Gerais, with over 90 species (Tavares et al. 2010; L. Moras personal communication), and third and fourth are São Paulo (79 species; Garbino 2016) and Rio de Janeiro (77 species; Peracchi and Nogueira 2010), respectively. The bat diversity of Espírito Santo, however, is still underestimated (Moreira et al. 2008; Pimenta et al. 2014). According to Pimenta et al. (2014), most bat inventories are concentrated in conservation units such as Reserva Biológica de Sooretama in central-eastern Espírito Santo, and Reserva Biológica Augusto Ruschi and Estação Biológica de Santa Lúcia, both in the central highlands. The southern highlands, where Domingos Martins is located, and the northwestern and central regions of the state, remain poorly sampled. Important for the refinement of our knowledge of the bat diversity in Espírito Santo is the careful examination of voucher material. In the type series of *Dryadonycteris capixaba*, for example, there has been a specimen available since 1977. This nectar-feeding bat is restricted to eastern Brazil and was recently discovered in the municipality of Linhares (Nogueira et al. 2012).

Among our new data, we obtained records which extend the distributions of two species to Espírito Santo. *Molossops neglectus* was previously recorded from the states of Minas Gerais, Pará, Paraná, Rio de Janeiro, Rio Grande do Sul, São Paulo, and Santa Catarina (Bernardi et al. 2007; Gazarini and Bernardi 2007; Reis et al. 2007; Freitas et al. 2011; Chaves et al. 2012a; Loureiro and Gregorin 2015; Althoff et al. 2018), and our records extend its known range by 380 km northeast from the previous closest locality in the state of Rio de Janeiro (Freitas et al. 2011). This molossid has been previously captured in canopy nets (~20 m) and ground-level nets (1-4 m) placed in forest edges or along forest trails, as in our study (Gregorin and Loureiro 2011; Taylor et al. 2019). *Myotis lavali* is distributed from the northeastern Brazil to Paraguay and northwestern Argentina (Barquez et al. 2017; Burgin et al. 2019), occurring in the Brazilian states of Pernambuco, Ceará, Bahia, Rio Grande do Norte, Paraíba, Piauí, Tocantins, Goiás, Minas Gerais, and Mato Grosso do Sul (Moratelli et al. 2011; Moratelli and Wilson 2013; Nogueira et al. 2015; Weber et al. 2019). Our record extends the distribution of *M. lavali* by 648 km from its nearest locality, the Fazenda Serra Azul in Jaíba, Minas Gerais (Nogueira et al. 2015). This species appears to be associated with semiarid and savana formations encompassing the Caatinga and Cerrado, but it also occurs in moist habitats such as in the Pantanal and the Atlantic Forest (Moratelli and Wilson 2013; Weber et al. 2019). Our records indicate the use of semideciduous seasonal forests at altitude lower than 900 m, as suggested by Burgin et al. (2019).

Several studies have demonstrated the use of rocky outcrops as roosts by *Nyctinomops laticaudatus* (Weber et al. 2007; Ortega et al. 2010; Talamoni et al. 2013;

Tavares et al. 2017), a species usually recorded by diurnal searches in roosts (e.g., Tavares et al. 2017). According to Avila-Flores et al. (2002), *N. laticaudatus* uses crevices and rocky outcrops as roosts to protect from predators and inclement weather (Kunz 1982). The crucial importance of rocky roosts for *N. laticaudatus* has been demonstrated by a large amount of data obtained for this species in the Brazilian states of Paraná, Pará, Goiás, Amazonas, Bahia, Ceará, Minas Gerais, Mata Grosso do Sul, Mato Grosso, Pernambuco, Piauí, Rio Grande do Norte, Sergipe and Tocantins (Arnone and Passos 2007; Silva et al. 2009; Chaves et al. 2012b; Cajaiba 2014; Guimarães and Ferreira 2014; Tavares et al. 2017). In large Amazonian rivers where natural seasonal pulses of flooding were disrupted by the permanent flooding caused by the filling of hydroelectric reservoirs behind dams, the permanent submergence of rocky outcrops represents a loss of shelter for bats, including populations of thousands of *N. laticaudatus* in the river Madeira (Less et al. 2015; Tavares et al. 2017). This species may also be affected by impacts caused by exploitation of terrestrial outcrops, although to the best of our knowledge this has not been formally reported.

The list of threatened fauna in the state of Espírito Santo includes 41 mammal species in the categories Vulnerable (10), Endangered (12), and Critically Endangered (19) (Costa et al. 2019). This state also harbors Near Threatened (4) and Data Deficient (29) mammals (Costa et al. 2019). Among Chiroptera, 17 species are classified as Data Deficient, one as Extinct, and four are categorized as Vulnerable, such as the case of *Lonchorhina aurita*, recorded here. Among the Data Deficient species, *Lionycteris spurrelli* is rarely sampled in southeastern Brazil, where only two previous records are available, one from a karstic area in Minas Gerais (Trajano and Gimenez 1998) and another from Santa Tereza, Espírito Santo (Woodman and Timm 2006). Therefore, our voucher specimen is only the second record of this species from the state.

The Atlantic Forest biome covers a great latitudinal area and has exceptional landscape diversity, including several associated ecosystems (mangroves, restinga, and rupestrial altitude fields), which results in a unique biological complex with high biodiversity (Lima and Capobianco 1997; Silva and Casteleti 2005). This broad latitudinal distribution includes geomorphological, climatic, and biological variation, contributing to the diversification of species and endemism (Martini et al. 2007; Carnaval and Moritz 2008; Lima 2014; Batista et al. 2021). Espírito Santo encompasses key areas for the preservation of the Atlantic Forest, extending from 17–21°S (IPES 2000) and including large areas of conserved native forests, such as the Reserva Biológica de Sooretama and the Reserva Natural Vale, which together constitute approximately 46,000 ha of Atlantic Forest (Taveira 2013). On the other hand, few efforts have been made to study the diversity of bats outside protected areas. Our rapid inventory in Domingos Martins, a previously unsampled region for bats, located in the intensively sampled Atlantic Forest biome, allowed us to extend the known distribution of two species and reveal a relatively diverse bat community.

In addition to highlighting the potential of Domingos Martins as an important area for biodiversity conservation of the southeastern Atlantic Forest—other bat inventories with similar capture efforts in this region found fewer species (e.g., Nobre et al. 2009; Chaves et al. 2012a; Pedroso et al. 2020)—our results also showed the importance of inventorying unprotected areas that may help to maintain viable local vertebrate populations and contribute to the regional pool of species biodiversity (Naniwadekar et al. 2015; Boron et al. 2016; Cox and Underwood 2019).

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Authors' Contributions

Formal analysis: MDAAA. Investigation: VDCT. Methodology: MDAAA, VDCT. Project administration: VDCT. Supervision: LMM. Writing – original draft: MDAAA, LMM. Writing – review and editing: LMM, VDCT.

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